RESPONSE FROM SES TO:

CONSULTATION PAPER ISSUED BY THE INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE

PROPOSED ALLOCATION OF SPECTRUM FOR INTERNATIONAL MOBILE TELECOMMUNICATIONS (“IMT”) AND IMT-ADVANCED SERVICES AND OPTIONS TO ENHANCE MOBILE COMPETITION

Issued by IDA on 22 April 2014

Contact Details of SES:

Kevin Seow

Vice President

Spectrum Management & Development

Kevin.Seow@ses.com

Lee Ting Ling

Manager

Spectrum Management & Development

tingling.lee@ses.com

Views and Comments of SES

SES would like to thank the Info-Communications Development Authority of Singapore (IDA) for the opportunity to respond to this consultation paper on proposed allocation of spectrum for International Mobile Telecommunications (IMT) and IMT-Advanced Services and options to enhance mobile competition.

We would like to raise our concerns on the possibility that the 3.5 GHz band (3400-3600 MHz), which is used by fixed-satellite service (FSS) systems in Singapore, may be allocated to commercial mobile uses in the near-to-mid-term.

The C-band, of which the 3.5 GHz band is a part, has been extensively used by the satellite industry since the first satellite networks were deployed over 40 years ago. Even though higher frequency bands are also available for FSS, C-band remains the preferred choice of many satellite users because of its ability to penetrate rain attenuation conditions. This key characteristic makes C-band suitable in fulfilling the communication needs of countries located in high rain zones. For these affected countries which are usually located within tropical or equatorial regions, including Singapore, C-band is a very crucial band as adverse meteorological conditions make the use of higher frequency bands very difficult or impossible. For many full-time, high-bandwidth FSS applications (such as TV distribution or contribution), consistently high availability rates even in the face of rain attenuation is a critical requirement.

Based on the ITU-R studies, sharing between IMT systems and FSS is not practicably feasible in the due to the minimum separation distances required to protect FSS earth station receivers from in-band and adjacent band interference. Such distances can range from about 5 km to even exceeding 100 km, depending on the type of interference mechanism. In addition, there is no well proven mechanism for ensuring mobile IMT devices are not transmitting within the minimum separation distances necessary to protect FSS earth.

In this paper, SES would like to provide its views and comments on Question 8 in Part II, which seeks information relating to the use of the 3.5 GHz band to be allocated for IMT and IMT-Advanced services. We have no comments on the other questions in this consultation paper.

Question 8: IDA seeks:

(a) indications of industry interest in the allocation of long term rights in the 3.5 GHz band, as well as planned services and target market segments for the use of these bands;

SES is of the understanding that there are earth stations in Singapore receiving FSS signals in the 3.5 GHz band. Such FSS earth stations in Singapore are using the 3.5 GHz band for myriad services, including TVRO, disaster relief efforts, telemetry operations (telemetry, tracking and ranging), cellular backhaul, maritime, satellite news gathering (SNG), very small aperture terminals (VSATs) and cable distribution. Increasing demand for FSS applications in the C-band due to its robustness towards rain attenuation suggests that demand for use of the 3.5 GHz band by the FSS is unlikely to decrease in the near- to mid-term, and may even increase.

Question 8: IDA seeks:

(b) Views on whether the use of the 3.5 GHz bands solely for the deployment of in-building mobile systems is feasible, and the underlying considerations thereof;

At the Joint Task Group 4-5-6-7 meeting held from 20-28 February 2014, in Geneva, the compatibility studies between FSS networks and IMT-Advanced systems deployed indoor have been finalised in the Draft New Report with the title "Sharing studies between IMT-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15". Based on the conclusions of the Draft New Report, in the case of IMT-Advanced small cell indoor deployment scenarios (please refer to Section (1) In-band emissions, paragraph three of the Summary of the Draft New Report in the Annex section):

> The required protection distance for an indoor small cell deployment was smaller relative to small cell outdoor due to the fact that some degree of building attenuation was assumed, as well as lower base station eirp and antenna height.
>
> For the long-term interference criterion, the required separation distances vary from about 5km to tens of kms. For the short-term interference criterion, the required separation distances vary from about 5 km to tens of kms, and in some instances up to 120km. Both the long-term and short-term interference criteria would have to be met.
>
> The wide range of distances is a consequence of earth stations in a variety of terrain conditions, assumed clutter loss, and different assumptions for the building penetration loss (0 to 20dB).
>
> The above mentioned separation distances were derived assuming an IMT Advanced deployment limited to indoor. If a percentage of IMT-Advanced user terminals are used outdoors, the required separation distances would normally be larger.

In view of the required separation distances which range from about 5km to tens of kms, and in some instances up to 120 km, the adequate amount of attenuation that would be required for indoor IMT-Advanced systems, in order to co-exist with FSS, would be substantial. Given Singapore's small geographic size (about 50 km at its widest), even modest FSS deployments in and around Singapore would have the effect precluding deployment of co-frequency IMT-Advanced systems in substantial areas.

Also, we believe that once mobile systems have been deployed in 3.5 GHz, it is difficult to guarantee and restrict its deployment to indoor applications only. We have a strong concern that once IMT systems start to proliferate in the outdoor environment, it will be extremely difficult to rely on an indoor-only restriction to control the interference into FSS earth stations. Based on the same Draft New Report (please refer to Section (1) In-band emission, first paragraph of the Summary of the Draft New Report in the Annex section), it was concluded that sharing between IMT-Advanced and FSS is not practically feasible in the same geographical area given the minimum separation distances involved and enforcement difficulties. According to the same report, for IMT systems that are deployed outdoor, the required separation distances range from tens of km to even exceeding 100 km, making sharing even less practical.

Such large separation distances would also raise cross-border coordination issues with Malaysia and Indonesia, especially if outdoor deployment were allowed, since the 3.5 GHz band is used for FSS in Malaysia.

Question 8: IDA seeks:

(c) Views on possible impact to end users of FSS and TVRO, if (i) the end users do not have to be migrated; or (ii) the end users have to be migrated; and

As noted above, the minimum separation distances needed to protect C-band FSS receivers from interference make sharing of the band with IMT impractical. And without a reliable mechanism for enforcing minimum separation distances for mobile devices, the likelihood is high that FSS and TVRO users in the 3.5 GHz and adjacent FSS bands – whether in Singapore or in nearby Malaysia or Indonesia) will receive harmful interference. It is worth noting that Indonesia previously experimented with Fixed Wireless Access in the 3.5 GHz band, but had to move such services into the 3.3 GHz band to avoid interference into in-band and adjacent C-band FSS receivers.

Migration of C-band end users is also not a feasible option. Relocation of FSS earth station receivers will rarely be feasible due to their size, the separation distances involved, and the need to C-band receivers in adjacent bands from out-of-band emissions. Migration of 3.5 GHz to higher bands will also not be feasible due to capacity constraints in higher parts of the C-band and the vulnerability of Ku- and Ka-band frequencies to rain attenuation in high rain zone equatorial countries, such as Singapore.

The fact that IMT Advanced systems deployed in the 3.5 GHz band can cause harmful interference into FSS earth stations deployed in the adjacent band 3.6-4.2 GHz was confirmed in the conclusions of the Draft New Report (please refer to Section (2) Adjacent band emissions of the Summary of the Draft New Report in the Annex section). In the case of adjacent band emissions for a specific IMT small cell deployment studied:

> **…**the required separation distances from the edge of the IMT-Advanced deployment area are in the range of 20 km to 5 km with an associated guardband of 1 MHz to 2 MHz respectively.

One study shows that the use of a common representative FSS receive LNA/LNB front-end RF filter provides an insignificant decrease in the required separation distance to protect the FSS earth station receiver from adjacent band emissions. Moreover, inclusion of an RF filter provides little additional rejection of adjacent band emissions over what is already provided by the IF selectivity of the tuner.

It should be noted that the Draft New Report conclusion was reached based on a "small cell" deployment. For "macro"-cell deployments operating at higher power, the out-of-band interference effects will be considerably greater. In sum, the population of FSS and TVRO users that may be impacted by the introduction IMT-Advanced will be larger than just the FSS users in the 3.5 GHz band, and will include FSS users in the adjacent 3.6 GHz band – making the option of migrating such users to another location or another band that much more difficult and infeasible.

Question 8: IDA seeks:

(d) Views on possible co-existence issues between TDD systems, and FSS and/or TVRO systems

We have not come across any studies between TDD systems and FSS and/or TVRO systems and hence we are unable to comment on whether co-existence is possible. The studies cited above are agnostic as to the type of IMT technology. In other words, the results do not change based on whether the IMT system uses TDD or FDD.

Annex

Due to the enormous size of the Draft New Report (Document 4-5-6-7/TEMP/140-E), only the Summary Section is provided in this Annex.

9 Summary

This Report has assessed technical feasibility of deploying IMT-Advanced networks considering sharing and compatibility with geostationary satellite networks in the FSS in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands.

The required separation distances to protect FSS receiving earth stations are summarized as follows with respect to the following different interference mechanisms.

(1) In-band emissions

In the case of IMT-Advanced suburban/urban macro-cell deployment scenarios:

> For the long-term interference criterion, the required separation distances are at least in the tens of km. For the short-term interference criterion, the required separation distances, including when the effects of terrain are taken into account, exceed 100 km for most of the cases. Both the long-term and short-term interference criteria would have to be met.
> In some cases, the required separation distances are larger, up to 525km. In other cases, the required separation distances could be reduced by taking into account additional effects of natural and artificial shielding. However these effects are site specific.

In the case of IMT-Advanced small-cell outdoor deployment scenarios:

> For the long-term interference criterion, the required separation distances are in the tens of kms. For the short-term interference criterion, the required separation distances, including when the effects of terrain and clutter are taken into account, are around 30 km in typical IMT-Advanced small-cell deoployment using low antenna height in urban environment. In some cases the required separation distances were found to exceed 100 km. Both the long-term and short-term interference criteria would have to be met.

In the case of IMT-Advanced small-cell indoor deployment scenarios:

> The required protection distance for an indoor small cell deployment was smaller relative to small cell outdoor due to the fact that some degree of building attenuation was assumed, as well as lower base station eirp and antenna height.
>
> For the long-term interference criterion, the required separation distances vary from about 5km to tens of kms. For the short-term interference criterion, the required separation distances vary from about 5 km to tens of kms, and in some

instances up to 120km. Both the long-term and short-term interference criteria would have to be met.

The wide range of distances is a consequence of earth stations in a variety of terrain conditions, assumed clutter loss, and different assumptions for the building penetration loss (0 to 20dB).

The above mentioned separation distances were derived assuming an IMT Advanced deployment limited to indoor. If a percentage of IMT-Advanced user terminals are used outdoors, the required separation distances would normally be larger.

FSS earth station receivers that are deployed with low elevation angles require a path between space and earth to and from the satellite that is clear of ground clutter. For this reason, it should not be assumed that clutter is available to attenuate emissions from an IMT-Advanced device that is located in the azimuth of the main beam of the FSS earth station receiver, especially those that have been installed with low elevation angles.

(2) Adjacent band emissions

Adjacent band compatibility between IMT-Advanced systems in the bands or parts of the bands 3 300-3 400 MHz / 4 400-4 500 MHz / 4 800-4 990 MHz and FSS systems in the bands 3 400-4 200 MHz/4 500-4 800 MHz have been studied.

- Using the long-term interference criteria, the required separation distance is from 5 km up to tens of km for IMT-Advanced macro-cell and from 900m to less than 5 km for IMT-Advanced small-cell outdoor deployments, respectively, with no guard band.
- In the case of IMT-Advanced deployment in the adjacent band, the separation distance between IMT Advanced base stations and a single FSS receiver earth station could be reduced by employing a guardband between the edge of the IMT-Advanced emission and FSS allocation.
- For a specific macro-cell deployment scenario studied, the required separation distances from the edge of the IMT-Advanced deployment area are in the range of 30 km to 20 km with an associated guardband of 2 MHz to 80 MHz respectively. Likewise, for a specific small-cell deployment studied, the required separation distances from the edge of the IMT-Advanced deployment area are in the range of 20 km to 5 km with an associated guardband of 1 MHz to 2 MHz respectively.

One study shows that the use of a common representative FSS receive LNA/LNB front-end RF filter provides an insignificant decrease in the required separation distance to protect the FSS earth station receiver from adjacent band emissions. Moreover, inclusion of an RF filter provides little additional rejection of adjacent band emissions over what is already provided by the IF selectivity of the tuner.

(3) LNA/LNB overdrive

The results show that emissions from one IMT-Advanced station can overdrive the FSS receiver LNA, or bring it into non-linear operation, if a macro cell deployment is closer than a required protection distance that ranges from 4 kilometres to 9 kilometres to an earth station in the band 3 400-4 200 MHz and 4 500-4 800 MHz. The required protection distance to prevent overdrive of the FSS receiver by IMT-Advanced emissions ranges from one hundred metres to 900 metres for the case of small cell deployments.

(4) Intermodulation

The required protection distance to prevent intermodulation interference produced in the receiver of the FSS earth station from being caused by multiple IMT-Advanced stations ranges from 2 kilometres to 8 kilometres in the case of macro cell deployments. The required protection distance in the small cell deployment scenario to limit the possibility of intermodulation interference being caused into the earth station receivers in the band 3 400-4 200 MHz and
4 500-4 800 MHz is at least 100 metres to as high as half a kilometre.

Conclusions

The sharing between IMT-Advanced and FSS is feasible only when FSS earth stations are at known, specific locations, and deployment of IMT-Advanced is limited to the areas outside of the minimum required separation distances for each azimuth to protect these specific FSS earth stations. In this case, the FSS protection criteria should be used to determine the necessary separation distances to ensure protection of the existing and planned FSS earth stations.

When FSS earth stations are deployed in a typical ubiquitous manner or with no individual licensing, sharing between IMT-Advanced and FSS is not feasible in the same geographical area since no minimum separation distance can be guaranteed.

Deployment of IMT-Advanced would constrain future FSS earth stations from being deployed in the same area in the bands 3 400-4 200 MHz and 4 500-4 800 MHz as shown by the studies.